Zagazig J. Agric. Res., Vol. 50 No. (3) 2023 343-350

Plant Protection and Pathology Research

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

BIOLOGY AND FEEDING POTENTIAL OF *Cydonia vicinia isis* Muls. (COLEOPTERA: COCCINELLIDAE) ON FOUR APHID SPECIES UNDER LABORATORY CONDITIONS

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Received: 30/05/2023 ; Accepted: 04/06/2023

ABSTRACT: In a laboratory setting at 22 ±1ºC and 65 ±5%, the growth and reproduction of the aphid species *Aphis craccivora* Koch, *Aphis gossypii* Glover, *Hyalopterus pruni* Geoffroy, and *Brevicoryne brassicae* L. as prey for the predator *Cydonia vicinia isis* Muls. The findings revealed that the prey species had a significant influence on the growth and predation rate of *C. vicinia isis* Muls. immatures. *A. craccivora* had the shortest total larval duration (13.25 days), while *H. pruni* had the longest (17.48 days). During its larval stage, *Cydonia vicinia isis* devoured significantly more *H. pruni* (250.51) individuals than *A. craccivora* (188.91), *B. brassicae* (232.18), and A. *gossypii* (213.86). Meanwhile, adult females consumed significantly more *H. pruni* (4081.33) than *B. brassicae*, *A. gossypii* (3715.67, 3621.67), and *A. craccivora* (3715.67, 3621.67). (2891.23). When females of *C. vicinia isis* were reared on *A. craccivora*, they had the highest fecundity (696.00 eggs). In addition, females and males reared on *H. pruni* lived longer than those reared on the other three aphid species. The study could provide useful information for using *C. vicinia isis* in IPM programmes in broad bean, cabbage, citrus, and stone fruit trees.

Key words: *Cydonia vicinia isis*, aphids, biology, feeding capacity.

INTRODUCTION

Aphids are the most damaging insect pests to various crops in Egypt and around the world. **(Ibrahim, 1994; Ali *et al.*, 2020).** Aphids cause damage by feeding on plant sap, causing direct injury to the plants. **(Ismail *et al.* 1991; Hadeer 2020).** Coccinellids play an essential role in aphid population density control. **(Al-Allan *et al.*, 2004; Jafari, 2011; Mohamed, 2014; Bahy El-Din and El-Khawas, 2020).**

Cydonia nilotica vicina Mulsant predator is found in various crops in Egypt **(Ghanim and El-Adl, 1987; El-Batran *et al.*, 1996)** The population of *C. vicina nilotica* was found on plants with few densities of *A. craccivora*, but high densities of aphid were found on the plants, indicating that the predator avoids attacking plants with high densities of *A. craccivora* **(El-Batran *et al.*, 2015).** Meanwhile, this deduction must be supported by empirical evidence. Furthermore, both the second and third instar larvae demonstrated high predation potential against *A. craccivora* **(Mandour *et al.*, 2006; Saleh *et al.*, 2017)**. *Cydonia vicina isis* and *C. vicina nilotica* play an important role as biological control agents in regulating the population density of aphids and other sucking insect pests **(Ghanim and El-Adl, 1983; Ghanim and El-Adl, 1987; Mohamed, 2001)**.

Cydonia vicina isis, a coccinellidea predator, preys on *A. nerii*, *A. craccivora*, and *B. brassicae* **(El-Batran *et al.* 2015; Zawrah *et al.*, 2020).** *Cydonia vicina nilotica* consumed more food at lower densities, indicating that this predator would have a significant effect on the *A. craccivora* population at lower densities. (**Mandour *et al.*, 2006; Jabbar *et al.*, 2020).**

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More importantly, coccinellids do not have a high rate of prey consumption **(Pervez and Omkar, 2003; Bahy El-Din, 2006)**. This contributes to the insufficiency of aphid bicontrol programs using only predatory coccinellids. As a result, in order to consider biocontrol of *A. craccivora*, predators must be released early, when aphid populations are low (**Jabbar *et al.*, 2020**).

The present study concentrated on the effects of various aphids on the biology, reproductive, and predation capacity attributes of *C. vicinia isis* under laboratory conditions.

MATERIALS AND METHODS

The current research was done at the Plant Protection Research Institute, Zagazig, Sharkia, Egypt, between September 2022 and January 2023 at Laboratory conditions 22 ±1ºC and 65± 5% R.H.

Rearing of Aphid Preys

Brevicoryne brassicae , *A. craccivora* and *A. gossypii* were reared in caged (60 × 60 × 80 cm) covered with a muslin on young seedlings of their hosts' cabbage , faba bean and citrus respectively, while *H. pruni* was obtained from peach orchards both of them were directly used as food sources for *C. vicinia isis*

The coccinellid *Cydonia vicinia isis*

Cydonia vicinia isis adults were collected from *A. craccivora* infested alfalfa fields. Adult *C. vicinia isis* cultures were collected from the field and placed in plastic jars with last aphids. The laid eggs were kept in Petri dishes (10cm) until they hatch. *Cydonia vicinia isis* eggs were collected daily and placed in new plastic cages. After hatching, neonate larvae were fed an adequate number of aphids until pupation. Pupae were collected and kept in a separate plastic cage until they emerged. This cycle was repeated on each prey species at least twice before it was used in the experiments.

Developmental Periods of Different *C. vicinia isis* Stages

Durations of larval and pupal stages and larval feeding capacity

Hundred eggs were collected from laboratory colonies and divided into five replicates for this experiment (20 eggs each). In a Petri dish (12 cm diameter), eggs were placed on moistened filter paper and monitored daily until hatching. Each replicate's hatched larvae were transferred into other Petri dishes (12 cm diameter) until pupation. Adult *C. vicinia isis* from all stocks were placed in a Petri dish (200 × 9 mm) for mating. Each mating pair was carefully placed in a Petri dish (100 × 9 mm) using filter paper.

Each couple was reared on only one type of aphid until egg depositing. Every day, the eggs were transferred to a new Petri dish (100 × 9 mm). Recently hatched larvae were placed individually in Petri dishes (100 × 9 mm). to estimate the developmental period of *C. vicinia isis*. Twenty larvae from each stock were fed the same aphid types as replicates. Each Petri dish received a known number of aphid nymphs every day. The first larvae of *C. vicinia isis* were reared on nymphs in their first and second instars. All aphid stages were presented to the larvae, from the second to the adult. The daily evolution, duration, and food consumption of larvae were recorded in each treatment.

Longevity and fecundity of *C. vicinia isis* adults

Adults from each treatment group were separated by sex and placed in a Petri dish (100 × 9 mm). Each adult was fed a set number of nymphs of the same species. Adult males and females from each handling group were placed in a large Petri dish (200 × 9 mm) and supplied with nymphs before being kept in group for mating seven days after emergence. Ten mating pairs were chosen for each treatment, placed in ten Petri dishes (100 × 9 mm) , and fed nymphs daily. After seven days, each mated pair was detached and individually put in a Petri dish (100 × 9 mm). The adults were fed aphid nymphs every day until they died. Throughout the lives of adult females and males, the number of preys devoured was recorded daily. The pre-ovipositional period was measured from the day of emergence to the day of oviposition. The number of eggs deposited per female was estimated daily during the ovipositional period, and the total number of eggs laid per female was recorded. In addition, the post-ovipositional period was calculated from the end of the ovipositional period until death.

Statistical Analysis

The data for the duration time and average of consumption per larval stage of the *C. vicina isis* that fed on A. gossypii and the means were detached using Dancan, s Multiple Rang Test **(Cohrot Software 2004)**.

RESULTS AND DISCUSSION

Incubation Period

Cydonia vicinia isis developed successfully on the majority of the tested preys; the mean incubation period (Table 1) for C. vicinia isis eggs on the four aphid species (*A. craccivora, A. gossypii, H. pruni, and B. brassicae*) was 3.14± 0.40, 3.49±0.50, 4.06± 0.12 and 3.49±0.84 days. The results revealed statistically significant differences in the mean incubation period among prey species.

Egg hatching (%) data presented in Table 1 reported that was significantly longer when fed *A. craccivora* (96.79%) than when fed *A. gossypii, H. pruni*, and *B. brassicae* (91.38, 89.11 and 88.98%).

Effect of Various Preys on

Development of immature stages

As shown in Table 1, larval development was prey-dependent, with significant differences in the duration of the first instar and total evolution time between tested preys. The first instar larvae of *C. vicinia isis* had a different impact when reared on (*A. craccivora, A. gossypii, H. pruni*, and *B. brassicae*) (2.75 ±0.32, 3.08± 0.50, 3.59 ± 0.13 and 3.33 ±0.39 days). The larval second and third instars grew significantly faster when fed *H. pruni* (3.44 ±0.11 and 4.26 ± 0.12 days) compared to those fed on *A. craccivora, A. gossypii* and *B. brassicae* (2.70 ±0.10, 3.18 ±0.90 and 3.33 ±0.62 days) for the second instar and (3.27±0.14, 3.57±0.4 and 3.69±0.10 days) for the third instar.

Cydonia vicinia isis had total larval periods of 13.25±0.83, 15.14± 0.10, 17.48± 0.91 and 16.19 ±0.92 days when reared on *A. craccivora, A. gossypii, H. pruni*, and *B. brassicae*. The larval periods were significantly shorter when reared on *A. craccivora* and significantly longer when reared on *H. pruni*. However, there were significant differences in pupal stage duration between *H. pruni* (7.2) and *A. craccivora, A. gossypii* (5.49 and 5.96). When *C. vicinia isis* was reared on *A. craccivora, A. gossypii, H. pruni*, and *B. brassicae*, the total duration periods of the immature stages were 22.88±1.49, 24.58±1.98, 28.74±2.89 and 26.78±0.48days, when the *C. vicinia isis* was reared on *A. craccivora*, *A. gossypii*, *H. pruni*, and *B. brassicae*. Furthermore, when the larvae were reared on *A. craccivora*, the total developmental period was significantly shorter than when reared on *H. pruni*. When *C. vicinia isis* was reared on *A. craccivora, A. gossypii, H. pruni*, and *B. brassicae*), the mortality percentages were 8.65, 13.57, 18.62 and 23.75%, respectively. The mortality rate of *C. vicinia isis* immature stages was significantly lower when reared on *A. craccivora* and significantly higher when reared on *B. brassicae* (Table 1).

These results are consistent with the findings of **Nadia Mohamed (2014)**, who found that the larval stage lasted an average of 15.891.8 days. During the four larval instars, the mortality rates were 8.65, 6.42, 4.51, and 1.2%, respectively. The pupal stage lasted 5.8±0.95days.

Feeding capacity of larvae

The nymphs of *Aphis craccivora, Aphis gossypii, H. pruni*, and *B. brassicae* devoured by the first instar of *C. vicinia isis* were 13.22± 0.47, 15.38±1.42, 18.99± 1.03and 16.49± 0.80 nymphs. The 2nd instar larvae devoured 25.31± 1.09, 31.77± 2.41, 38.88±2.71 and 35.66± 1.11 individuals. The number of individuals devoured by the 3rd instar larvae was 56.33 ±1.03, 61.03 ± 1.38, 71.30 ±2.32 and 65.69±1.58 individuals. The 4th instar devoured 94.05 ±2.4, 105.88 ± 4.09, 121.33 ±5.32 and 116.0 ± 5.2 fed on *A. craccivora*, *A. gossypii*, *H. pruni*, and *B. brassicae* were 188.91 ±4.12, 213.86 ± 6.63, 250.51 ± 6.58 and 232.18±7.14 individuals. The individuals of *H. pruni* devoured by the four larval instars of *C. vicinia isis* were significantly longer than those consumed by the other aphid species. Individuals devoured by *B. brassicae*, on the other hand, were significantly higher than those devoured by *A. craccivora*. As a result, *C. vicinia isis* larvae were more aggressive toward *H. pruni* than the other aphid species (Table 2).

Table 1. Effect of different prey species on the development of *C. vicinia isis* immature stages at 22±1 ºC and 65±5% R.H

Prey species	Egg hatching (%)	Incubation period	Larval developmental period (instars)				Total larval period	Pupal period	Total immature stages	Mortality %
			1st	2nd	3rd	4th				
A. craccivora	96.79± 2.89[a] (83-100)	3.14 ± 0.4[c]	2.75± 0.32[d]	2.70± 0.10[c]	3.27± 0.14[c]	4.53± 0.15[c]	13.25± 0.83[d]	5.49± 0.38[b]	22.88 ± 1.49[d]	8.65± 0.34[c]
A. gossypii	91.38±2.72 [b] (82-100)	3.49 ± 0.5[b]	3.08± 0.50c	3.18± 0.09[b]	3.57± 0.4[b]	5.31± 0.17[b]	15.14± 0.10[c]	5.96± 0.09[b]	24.58± 1.98[c]	13.57± 0.59[bc]
H. pruni	89.11±3.05 [b] (87-100)	4.06 ± 0.12[a]	3.59± 0.13[a]	3.44± 0.11[a]	4.26± 0.12[a]	6.05± 0.18[a]	17.48± 0.91[a]	7.20± 0.19[a]	28.74± 2.89[ab]	18.62± 1.07[ab]
B. brassicae	88.98±4.09 [b] (76-100)	3.49 ±.0.84[b]	3.23± 0.39[b]	3.33± 0.62[a]	3.69± 0.10[b]	5.84± 0.12[a]	16.19 ± 0.22[b]	6.93± 0.21[a]	26.78± 0.48[a]	23.75± 1.18[a]
LSD 0.05	5.0462	0.2349	0.18687	0.17638	0.2889	0.4234	0.57882	0.75216	1.3358	8.3675

Table 2. Effect of different prey species on feeding capacity of *C. vicinia isis* larvae at 22±1 ºC and 65±5% R.H.%

Prey species	1st instar	2nd instar	3rd instar	4th instar	Total
A. craccivora	13.22±**0.47**[c]	25.31±**1.09**	56.33±**1.03**[d]	94.05±**2.40**[c]	188.91± **4.12**[d]
A. gossypii	15.38±**1.42**[c]	31.77±**2.41**[c]	61.03±**1.38**[c]	105.88±**4.09**[b]	213.86±**6.63**[c]
H. pruni	18.99±**1.03**[a]	38.88±**2.71**[a]	71.30±**2.32**[a]	121.33± **5.32**[a]	250.51±**6.58**[a]
B. brassicae	16.49±**0.80**[ab]	35.66±**1.11**[b]	65.69±**1.58**[b]	116.00±**5.20**[a]	232.18± **7.14**[b]
LSD 0.05	2.5213	1.2042	0.32684	9.6408	14.449

Mean under each variety having different letters in the same raw denote a significant different ($p \leq 0.05$).

These findings are consistent with the findings of **El-Batran *et al.* (1996)** who discovered that *C. vicina nilotica* consumes (191, 475, and 500 individuals) *B. brassicae* during the larval period, both female and male. **Nadia Mohamed (2014)** found that the average consumption of larval instars was 74.56±1.92, 56.86 ± 1.2, 155.97 ± 6.85 and 390.77 ± 1.96 individual.

Longevity of adults

Females reared on *A. craccivora* had the shortest pre-ovipositional period (5.84 ± 0.92 days), followed by *A. gossypii* and *B. brassicae* (7.92±1.02 and 8.49 ±1.19 days). The longest period was recorded when beetles fed on *H. pruni* (9.30±2.04 days). The beetle's ovipositional period was significantly shorter when fed *H. pruni* (47.64 ±4.25 days) compared to *A. gossypii* and *B. brassicae* (38.33±2.91 and 44.13±3.01 days) and *A. craccivora* (41.13±3.03 days). When *C. vicinia isis* was fed *A. gossypii*, the post-ovipositional period was significantly longer (14.03± 1.68days).

On the other hand, when females were fed *A. craccivora* (8.43 ±1.87 days) while, it was (11.75 ± 2.34and 13.83 ±2.56 days) when they were fed *B. brassicae* and *H. pruni*. Adult life span was significantly higher in females fed *H. pruni*(70.77±6.10 days) or *B. brassicae* and *A. gossypii* (64.37± 4.09and 60.28±4.07 days) and significantly lower in males fed *A. craccivora* (55.41±3.14 days). Males lived significantly longer when fed *H. pruni* (58.33± 4.01days) or *B. brassicae* and *A. gossypii* (51.69±2.69 and 44.67±2.91 days) and significantly shorter when fed *A. craccivora* (41.7±2.67 days). The females lived greater on last aphids types than males. In general, Adult *C. vicinia isis* lived longer when reared on *H. pruni* and lived shorter when reared on *A. craccivora* (Table 3). This is consistent with **Nadia Mohamed 2014** study, which stated that the predator female fed1649.64±22.75 individuals (*A. gossypii*) over the course of 51.8 ± 4.16 days. The pre-oviposition period lasted an average of 5.5±0.79 days. During this time, the predator female consumed 354.8±6.5 nymphs. *Cydonia vicinia isis* female devoured an average of 1050.17±15.85 individuals during the ovipasition period, which lasted an average of 26.54±2.96 days.

Feeding capacity of adults

When reared on *A. craccivora*, the pre-ovipositional period was significantly shorter (5.84 ±0.92 days), followed by *A. gossypii* and *B. brassicae* (7.92± 1.02and 8.49 ±1.19 days), respectively. During this time, the predator female consumed 341.0 ± 8.99, 497.67 ±1 2.79, 533.67 ± 11.16 and 464 ± 7.95 individuals on the last aphid species, with daily rates of 58.32, 62.41, 56.64 and 54.49 individuals, respectively. When fed *A. craccivora, A. gossypii, H. pruni,* and *B. brassicae,* the predator female consumed 2047, 2332, 2904.33, and 2626.33 individuals with a daily rate of 59.69,.55.99,51.12, and 54.14 individuals (Table 3). On the same aphid species, the number of deposited eggs per predator female averaged 696.00, 553.00, 446.0, and 392.33 eggs, with a daily rate of 16.92, 14.42, 9.39, and 8.93 eggs per day on the same aphid species Table 4. The predator female consumed 503.33±12.79, 792±10.27, 709.0 ± 15.64 and 635.33± 17.53 individuals with a daily rate of 59.69, 56.32, 51.12 and 54.29 individuals reared on *A. craccivora, A. gossypii, H. pruni*, and *B. brassicae* during the post-oviposition period Table3. A mated female reared on *A. craccivora* had a feeding capacity of 2891.33±109.67 due to their longevity. When fed *A. gossypii* and *B. brassicae*, this value increased significantly (3621.67±112.40 and 3715.67 ± 126.2). When reared on *H. pruni*, it reached its maximum consumption value (4081.33±137.4). Similarly, mated males fed *A. craccivora* to 2189.33 ± 92.21, ncreased significantly 2305.65±79.40 and 2750.0±99.46 when reared on *A. gossypii* and *B. brassicae*, respectively, and reached a maximum (2840.0 ± 103.2) when reared on *H. pruni*. *C. vicinia isis* consumed more *H. pruni* individuals than the other aphid species combined (Table 4). This is consistent with the findings of **Mandour *et al.* (2006)**, who found that the average food consumption of *C. vicina nilotica* was higher at lower densities, indicating that this predator would have a significant effect on the *A. craccivora* population at lower densities. **Mohamed (2014)**, on the other hand, reported that the predator female consumed 244.674.4 people over a period of 19.76±1.6 days , with a daily rate of 12.38 people (*A. gossypii*).

Table 3. The adult longevity and food consumption of *C. vicinia isis* reared on four aphid species at 22±1 ºC and 65±5% R.H.%

Prey species	Female longevity								
	Pre- oviposition			Oviposition			Post-oviposition		
	Period (days)	Daily Average consumption	Average of total consumption	Period (days)	Daily Average consumption	Average of total consumption	Period (days)	Daily Average consumption	Average of total consumption
A. craccivora	5.84±0.92^{a}	58.32±4.43^{a}	341±8.99^{b}	41.13 ± 3.05 ^{b}	59.69±5.06a	2047± 47.3c	8.43±1.87^{b}	59.69±5.16 a	503.33± 12.79b
A. gossypii	7.92±1.02^{c}	62.41±3.07^{a}	497.67±12.79^{ab}	38.33±2.91^{c}	55.99±4.39ab	2332±79.23 bc	14.03± 1.68^{d}	56.32± 4.01ab	792±10.27 a
H. pruni	9.30 ±2.04^{a}	56.84±5.57^{a}	533.67±11.16^{a}	47.64± 4.25^{a}	51.12±2.97c	2904.33±88.86 a	13.83± 2.56^{a}	51.12±3.71. c	709±15.64 ab
B. brassicae	8.49±1.19^{b}	54.49±5.25^{a}	464±7.95^{ab}	44.13± 3.01^{c}	54.14±2.77bc	2616.33±96.15ab	11.75± 2.34^{c}	54.29± 2.89bc	635.33±17.53 ab
LSD 0.05	1.6757	6.6653	170.419	5.039	4.578	496.724	3.220	4.6584	206.433

Mean under each variety having different letters in the same raw denote a significant different ($p \leq 0.05$).

Table 4. Feeding capacity and fecundity of *C. vicinia isis* reared on four aphid species under laboratory conditions 22±1 ºC and 65±5% R.H.%

. Prey species	Adult stages					
	Female				Male	
	Longevity	Average of consumption	Fecundity(No. of eggs)		Longevity	Average of consumption
			Total eggs	Daily		
A. craccivora	55.41± 3.14^{b}	2891.33±109.67b	696 ±11.02^{b}	16.92± 1.07^{a}	41.70±2.67^{a}	2189.0±92.21a
A. gossypii	60.28± 4.07^{c}	3621.67±±112.40ab	553±10.12^{a}	14.42±0.99 ^{b}	44.67±2.91^{c}	2305.65±79.4a
H. pruni	70.77± 6.10^{a}	4081.33±137.4a	446±16.02^{b}	9.39±0.75^{c}	58.33± 4.01^{a}	2840.0±103.2a
B. brassicae	64.37± 4.09^{c}	3715.67±126.2a	392.33 ± 9.97$_{b}$	8. .93± 1.01^{c}	51.69±2.65^{c}	2750.0±99.46a
LSD 0.05	8.3510	793.664	42.7769	1.200	9.1633	722.148

Mean under each variety having different letters in the same raw denote a significant different ($p \leq 0.05$).

Fecundity

Number of eggs deposited per female was significantly higher in females reared on *A. craccivora* (696.0±11.02) than those reared on *A. gossypii* (553.33±10.12). When adults were reared on *H. pruni* and *B. brassicae*, the number of eggs deposited was significantly lower (446.0± 16.02 and 392.33±9.97). In other words, females raised on *A. craccivora* were more fertile (Table. 4). On the contrary, the average number of deposited eggs per predator female was 680.95±9.84 eggs, with a daily rate of 25.66 eggs **(Nadia Mohamed 2014)**.

Conclusion

Finally, aphid species had an impact on the biological aspects of *C. vicinia isis A. craccivora* was a better prey than other prey where *C. vicinia isis* developed well. The current study could be critical for mass production of *C. vicinia isis*.

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البيولوجي والكفاءة الافتراسية للمفترس ابو العيد الاسود عند تربيته علي أربعة أنواع من المن تحت الظروف المعمليه

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أجريت الدراسة لتقييم دورة الحياة ومعدل التكاثر للمفترس ابوالعيد الاسود عند تربيته علي افراد حشرات من اللوبيا ومن القطن ومن البرقوق الدقيقي ومن الصلبيات تحت الظروف المعمليه 1± 22 ورطوبه نسبيه 65 ± 5%، النتائج: اوضحت النتائج ان لأنواع المن تأثير معنوي علي بيولوجيا ومعدل الافتراس للاطوار غير الكامله لهذا المفترس. وكانت أقصر فترة نمو كليه للاطوار اليرقيه 13.25 يوم عند تغذية المفترس علي حشرات من اللوبيا بينما كانت أطول فترة 17.48 يوم عندما تم تربية المفترس علي من البرقوق الدقيقي. وكان لمعدل الافتراس خلال الطور اليرقي تأثير معنوي 250.51 فردا من جشرات من البرقوق الدقيقي بينما كانت 188.91 فردا من حشرات من اللوبيا و 232.18 فردا من حشرات من الصلبيات و 213.86 فردا من حشرات من القطن. وكان لمعدل الاستهلاك الكلي للإناث تأثير معنوي عند التغذيه علي من البرقوق الدقيقى (4081.33 فردا) مقارنة بمن الصلبيات (3715.67 فردا) ومن القطن (3621.67 فردا) ومن اللوبيا (2891.33 فردا). وكان أعلي معدل لوضع البيض (696 بيضه) عند تربية اناث المفترس ابو العيد الاسود علي حشرات من اللوبيا، وكان طول حياة المفترس للذكور والاناث أطول عندما تم تربيته علي افراد من البرقوق الدقيقى مقارنة بأنواع المن الثلاثة. وتمدنا الدراسة بمعلومات مفيدة حول الاستفادة من المفترس في برامج المكافحة المتكاملة لحماية نباتات الفول البلدى والكرنب والموالح والفاكهة الحجرية من الإصابة يجشرات المن والحشرات الثاقبة الماصة.

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